TECHNICAL SPECIFICATION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES
(AMENDMENTS/SUPPLEMENTS TO IEC 298)

DEP 33.67.51.31-Gen.

July 1998

DESIGN AND ENGINEERING PRACTICE

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell International Oil Products B.V. (SIOP)
and
Shell International Exploration and Production B.V. (SIEP)
and
Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal or its technical advisor.

The right to use DEPs is granted by SIOP, SIEP or SIC, in most cases under Service Agreements primarily with companies of the Royal Dutch/Shell Group and other companies receiving technical advice and services from SIOP, SIEP or SIC. Consequently, three categories of users of DEPs can be distinguished:

1) Operating companies having a Service Agreement with SIOP, SIEP, SIC or other Service Company. The use of DEPs by these Operating companies is subject in all respects to the terms and conditions of the relevant Service Agreement.

2) Other parties who are authorized to use DEPs subject to appropriate contractual arrangements.

3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, SIOP, SIEP and SIC disclaim any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof. The benefit of this disclaimer shall inure in all respects to SIOP, SIEP, SIC and/or any company affiliated to these companies that may issue DEPs or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of SIOP and SIEP, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of SIOP and SIEP. The copyright of DEPs vests in SIOP and SIEP. Users shall arrange for DEPs to be held in safe custody and SIOP or SIEP may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

TABLE OF CONTENTS

APPENDICES

PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for high voltage switchgear and controlgear assemblies.

Part II of this DEP amends and supplements IEC 298 (1990, plus Amendment 1 of 1994-11). The additional requirements in this DEP are needed in order to:

a. make selections from the options given in IEC 298;

b. specify additional and more stringent requirements, as necessary, for operatiing and maintaining the gear in continuously operating plants,

c. Specify supplementary provisions required to make the gear suitable for operation in the overall process control design.

NOTE HV switchgear in the range from 1 to 36 kV is often referred to as Medium Voltage (MV) switchgear.

This DEP is a revision of the DEP with the the same number, dated July 1996. A summary of the main changes is given in Section 1.5.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F", as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilites and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

See Part II, Section Three.

1.4 CROSS-REFERENCES

Where cross-references are made, the number of the section or sub-section referred to is shown in brackets.

All publications referred to in this DEP are listed in (Part III).

1.5 SUMMARY OF MAIN CHANGES

The primary reason for this revision was to add Appendix 1 to cover gas-insulated switchgear. Only a few technical changes have been made to the remainder of the DEP.

A summary of the main changes is as follows:

Section	Description
General	References to IEC standards updated throughout to reflect new IEC numbering system
4.2	Reference to IEC 60694 amended to remove specific table selection
SECTION FIVE	Busbar system segregation changed
5.101	Degree of protection changed
5.113.2.1	Degree of protection changed
HH.3.1	Degree of protection changed
Appendix 1	New Appendix for gas-insulated switchgear

PART II AMENDMENTS/SUPPLEMENTS TO IEC 298

In this part, sections of IEC 298 are amended or supplemented, or new sections are added. Sections of IEC 298 that are not mentioned shall remain applicable as written.

SECTION TWO SERVICE CONDITIONS

Add to this Section:

2.1 ATMOSPHERIC CONDITIONS FOR INDOOR INSTALLATIONS

The atmospheric conditions inside the switch houses shall normally be in accordance with IEC 298. However, allowance shall be made for the entry of dust, salt, and sulphur contaminated air when doors are open or cable entrances through the floor are uncovered during maintenance and construction periods. Depending on the area where the switchgear will be installed, condensation inside the switchgear during the above periods cannot always be excluded. Proper measures, e.g. by installing panel heaters, shall be considered.

2.2 ATMOSPHERIC CONDITIONS FOR OUTDOOR INSTALLATIONS

The air can be laden with dust, salt or sulphur as encountered in the petrochemical industry or in oil fields. Condensation as a result of high humidity shall be considered.

2.3 SPECIAL SERVICE CONDITIONS

The requisition will specify any special service condition that the switchgear may be required to withstand in its operational location and that may arise during transport, storage and erection, e.g. shock and vibration or extreme temperatures.

Unless otherwise specified, the switchboard shall be suitable for installation in a non-hazardous area as defined in IEC 60079-10.

SECTION THREE TERMS AND DEFINITIONS

Add to this Section:

3.1 GENERAL DEFINITIONS

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The **requisition** is DEP 33.67.51.93-Gen., requisition for HV switchgear and controlgear assemblies.

NOTE DEP 33.67.51.80-Gen. ("Schedule for HV switchgear and controlgear assemblies") is normally attached to the requisition.

3.2 ADDITIONAL TECHNICAL DEFINITIONS

- Buscoupler

  A mechanical switching device to connect the two busbar systems of a double busbar arrangement.

- Restarting relay (RR)

  A relay to initiate the reclosure of a motor circuit under predetermined conditions, after a voltage depression or interruption.

- Section

  A constructional unit consisting of a number of panels connected to a continuous busbar system.

- Sectionalizing switch

  A mechanical switching device to connect the busbar systems of two sections.

- Time delayed restarting relay (TMR)

  A time delayed relay to initiate a delayed reclosure of a motor circuit, controlled by the process control system, under predetermined conditions, after a voltage depression or interruption.

SECTION FOUR RATED CHARACTERISTICS

Add to this Section:

4.1 RATED VOLTAGE

The nominal voltage will be stated on the requisition including information on the system earthing, e.g. isolated, earthed via an impedance, or solidly earthed.

4.2 RATED INSULATION LEVEL

The insulation level of the switchgear shall be in accordance with IEC 60694.

4.3 RATED FREQUENCY

The rated frequency may be 50 or 60 Hz and shall be stated on the requisition. Frequency variations between plus and minus 5% shall be acceptable.

4.4.1 Rated normal current

The rated normal current shall be as indicated on the requisition. The current rating of the incoming, sectionalizer and buscoupler switches shall be the same. The main busbar systems shall be fully current rated over the entire length of the switchgear and shall not be rated lower than the current rating of the incoming, sectionalizer and buscoupler switches.

SECTION FIVE DESIGN AND CONSTRUCTION

Add to this Section:

Switchgear and control gear shall be designed to minimize any risk of short circuits and to ensure personnel and operational safety during all operating conditions, inspections and maintenance.

It shall be designed for continuous operation at full load for at least 40 000 hours without maintenance that would require the circuit or busbar system to be de-energized.

Equipping and commissioning of spare panels as well as connecting main, control and auxiliary cabling shall be possible whilst the switchgear is live and in operation.

Switchgear and controlgear shall be of the metal-clad, withdrawable type, having either a single or double busbar system, and consist of a number of separate panels assembled into one or more sections. Sections shall be electrically interconnected by a sectionalizing switching device.

Double busbar systems shall have facilities for being electrically coupled for each section by a buscoupler. The busbar systems shall be fully segregated, making it possible to work on and extend one system safely when the other system is energized.

Facilities for extension of the gear shall be provided at both ends.

The lay-out of the operational front and the location of the components of the assembly shall be arranged in a logical and systematic sequence and standardized throughout. No operational equipment or metering apparatus shall be located at levels below 200 mm and above 2 000 mm. When the latter is not possible due to space constraints, details of the equipment to be installed above 2 000 mm shall be given in the quotation.

Alphanumeric notation, generally in accordance with IEC 60445, shall be used for identification and marking of phases, conductors and terminals.

For panel arrangements and schematics refer to standard drawings series S 67 as listed in (Part III).

5.1 REQUIREMENTS FOR LIQUIDS IN SWITCHGEAR AND CONTROLGEAR

Add to this clause:

Liquids shall only be applied as switching or insulation medium under special circumstances and after approval of the Principal.

5.2 REQUIREMENTS FOR GASES IN SWITCHGEAR AND CONTROLGEAR

Add to this clause:

Gases other than atmospheric air may be used as switching medium, but shall only be applied as insulation medium under special circumstances and after approval of the Principal.

5.3 EARTHING

Add to this clause:

For direct connection to the station earthing grid, earthing bolts of at least M10 shall be provided at both ends of the main earth bar.

An integrally mounted three phase earthing switch, capable of making and carrying the prospective short circuit current, and suitable for local, manual operation, shall be provided on the cable side of all HV switching devices.

The operation of the earthing switch shall be interlocked, allowing closure of the earthing switch only when the HV switching device is not in the service position.

Earthing facilities for the earthing of the busbar system of each section shall also be

provided. This should be arranged via the incoming HV switching devices or alternatively by a withdrawable earthing device capable of making and carrying the prospective short circuit current. The Manufacturer shall separately quote for one or more withdrawable earthing devices when applicable.

Circuit earthing devices shall be arranged for local, manual operation only. Earthing devices for motor starters may be automatically applied when the starter is withdrawn.

Earthing devices shall be equipped with a mechanically operated position indicator which shall be clearly visible without removal or opening of panel doors or covers.

Padlocking facilities shall be provided for locking the earthing device in the open and closed position.

When an earthing device has been fitted in a compartment, it shall not be possible to insert a withdrawable switching device into the service position of the compartment concerned.

Clear instructions, preferably pictorial, shall be installed showing the methods of earthing.

5.4 AUXILIARY EQUIPMENT

Add new sub-clause:

5.4.1 Auxiliary contacts

Auxiliary and control circuit connections on withdrawable switching devices shall be made either with self-aligning plug and socket contacts or with a multi-conductor cable with plug and socket arrangement.

In order to allow connections to remote alarm and indicating devices, each HV switching device (8) shall at least be provided with 2 sets of spare potential free auxiliary contacts, directly operated by the operating mechanism. One set shall be normally open and one set normally closed.

The contacts shall be wired up to the terminal blocks in the LV control compartment.

Add new sub-clause:

5.4.2 Secondary wiring and terminals

Secondary wiring shall not be mounted direct to metal. To accommodate and support the wiring, covered plastic channels, insulated tubes or plastic strips shall be used. The filling factor for channels and tubes shall not exceed 70%.

Internal wiring between panels shall be adequately protected against mechanical damage by e.g. rubber grommets. Wiring passing through HV compartments shall be installed in conduit or trunking to facilitate the replacement of the wiring without the need to de-energise the HV compartment.

The minimum cross section for wiring of current transformer secondary circuits with 5 A rating shall be 2.5 mm^2.

For bus wiring and outgoing control circuits, individual terminals shall be provided for each external conductor. These terminals shall be of the non-loosening, wedge or cage type construction, obviating the use of cable lugs and constructed in such a way that direct contact between screw, bolt or nut and conductor is avoided.

NOTE For the termination of internal secondary wiring, push-on connections with insulation support of the compression type may be used.

Wiring and terminals shall be identified in accordance with the related wiring diagrams.

5.9 NAME PLATES

Add to this clause:

Name, identification, instruction and warning plates and their fixing materials shall be of durable, corrosion resistant material. They shall be provided with indelible inscriptions in the language as specified on the requisition. Plates mounted on the outside of the equipment

shall be fixed by means of durable self-threading screws or pop rivets.

Add new sub-clause:

5.9.1 Nameplate information

The following information shall be given on the nameplate installed outside the assembly:

a. Manufacturer's name or trade mark;
b. type designation;
c. customer's purchase order number;
d customer's switchboard title and tag number;
e. year of manufacture;
f. service voltage;
g. rated frequency;
h. rated current of busbar system;
i. rated voltage of auxiliary circuits (if applicable);
j. rated peak and short time withstand current and withstand time;
k. degree of protection.

Add new sub-clause:

5.9.2 Circuit labels

Each circuit of the assembly shall be provided with the following circuit identification labels:

a. Circuit identification tag number in accordance with standard drawing S 67.027. The circuit labels shall be repeated on the fixed portion of a withdrawable or removable unit and at the main and auxiliary cable terminations that are not clearly identifiable from the physical layout, e.g. cable compartments at the rear or bottom of the assembly.

b. Identification number of connected equipment or circuit destination as specified in DEP 33.67.51.80-Gen. attached to the requisition.

Add new sub-clause:

5.9.3 Synoptic diagram

Assemblies shall be provided with a durable one-line synoptic diagram, clearly indicating the specific function of the different compartments if this is not clear from the general layout.

Add new sub-clause:

5.9.4 Instruction plates

If the operating sequence of certain equipment in the assembly is not evident, e.g. mechanical interlocking features, instruction plates shall be provided fixed near the point of operation. The instruction shall be given as far as possible in a pictorial manner.

Add new sub-clause:

5.9.5 Warning plates, caution notices

In locations where dangerous situations may inadvertently be created, warning plate(s) or caution notice(s) shall be installed, identifying the danger point(s). This may be either in a compartment or on the outside of an assembly.

5.101 DEGREE OF PROTECTION AND INTERNAL FAULT

Add to this clause:

The degree of protection of the enclosure shall be at least IP 4X as specified in IEC 60529. The floor of the switchhouse shall not be considered to be part of the enclosure. The top of the switchgear shall be sealed to such an extent that the ingress of dripping water is prevented.

The degree of protection for the partitions between compartments shall be at least IP 3X, which shall be maintained under all operational conditions.

The degree of protection between panels shall be at least IP 4X, which shall be maintained under all operational conditions. Through wiring solely between the LV compartment of different panels shall have a degree of protection of at least IP 3X. Busbar compartments of different sections of the switchboard shall have a partition with a degree of protection of at least IP 4X.

NOTE Busbar compartments of a section do not need to have partitions between the individual panels.

LV compartments shall be easily accessible and, when opened, shall offer a degree of protection of at least IP 2X towards any live part inside the compartment and on the door.

If anti-condensation heating is required inside the assembly, it shall be supplied from a separate LV source connected between system phase and neutral. The heating system of each section shall be separately protected and switched for isolation purposes by means of a miniature circuit breaker in combination with an earth leakage protecting device of 30 mA, which shall have a separate contact wired up to terminals to provide a remote alarm. When the heating system is live, this shall be indicated by means of a prominently situated red light.

Switchgear enclosures shall comply with Annex AA with regard to their mechanical strength in the event of an internal arc. The test performance shall be in conformity with accessibility type A.

All switchgear assemblies with a short circuit rating of up to 25kA (rms) shall be type-tested for their rated short circuit current with an arc duration of 0.5 s minimum; however, testing for a duration of 1 s is preferred. Switchgear of higher ratings shall as a minimum be subjected to the above type test at 25kA (rms). In addition to this, the pressure withstand capability of the enclosures shall be proven by type testing at the rated short circuit current for a minimum duration of 0.1 s.

The test shall be executed for all separate compartments within the functional unit containing HV equipment, i.e. busbar compartment, circuit breaker/contactor compartment and cable compartment.

Type test reports regarding internal arc withstand performance shall be available in the quotation stage.

5.102 ENCLOSURES

5.102.1 General

Add to this sub-clause:

Enclosures shall be free standing and self supporting.

All components requiring periodic maintenance shall be easily accessible. Cable installation work on functional units (replacements or new installations) and equipping of spare panels must be safely possible without de-energizing adjacent units.

All structures, sheeting and other metal parts shall be adequately protected against corrosion. Frame and partitions may be of galvanised steel without further paint coating. Those parts/covers requiring painting shall be properly pre-treated before the final coat(s) of oil resistant finishing paint is applied. Manufacturer's standard colour is acceptable. If a Manufacturer does not have a standard colour, light grey is preferred for external surfaces.

5.103 PARTITIONS AND SHUTTERS

5.103.3 Shutters

Add to this sub-clause:

Shutters shall be closed and opened automatically by the mechanical drive of the removable part of the switching device when the latter is being racked out of or into the service position.

Each set of shutters, both for the busbar and the cable side, shall be fitted with individual padlock facilities in its closed position. Only in motor starting units may the shutters on the cable side be omitted. Shutters shall be marked as follows:

'BUSBAR' on shutters covering busbars,

'INCOMING SUPPLY' on shutters covering incoming feeder cables,

'CIRCUIT' on shutters covering outgoing feeder cables.

To facilitate testing, a manually operated device shall be installed to permit opening and fixing in the open position, but not padlocking, of each set of shutters individually. The device shall be overridden by the moving part of the switching unit, restoring the automatic features of the shutters.

Add new clause:

5.108 BUSBAR SYSTEMS

Busbar systems shall be located in separate, air filled compartments and the busbars including the branch connections shall be fully insulated. The insulation shall be rated to withstand at least the line voltage of the system. This shall be verified by a type test in which the line voltage will be applied between the busbar and an aluminium foil wrapped closely around the insulation over a length of at least 300 mm. The duration of this type test shall be 60 minutes, during which the insulation must remain intact. The insulation shall be continued as far as practicable into the outgoing switching device and cable compartments up to the next current protective device. In incoming panels the insulation, or alternatively segregation, shall be extended up to the terminals of the incoming cables. Provisions shall be made at the bolted connections to enable accessibility for maintenance and extensions when appropriate.

Busbars shall be made of copper. Aluminium bars may be considered, but shall be subject to approval by the Principal.

Busbars and connections shall be fully rated, braced and supported to withstand the dynamic, thermal, and di-electric stresses over the full length of the switchgear.

All bolted connections shall be made with high tensile strength bolts effectively secured against loosening.

Add new clause:

5.109 SPARE PANELS

Unless otherwise specified with the requisition, each HV switchgear section shall have at least one spare panel. In case of a three section switchboard, the centre section shall be equipped with two spare panels. Spare panels shall be provided with the necessary components enabling future completion without the need for de-energizing the switchgear or adjacent panels.

Add new clause:

5.110 VOLTAGE TRANSFORMERS

Voltage transformers shall be in accordance with IEC 60186. The rated output shall match the maximum load of the equipment connected plus 25%, and should be selected from the range of standard values. The preferred secondary voltage is 110 V.

Voltage transformers for measuring purposes shall be of accuracy class 3, except those for measuring the supply of third parties, which shall be of class 1. Voltage transformers for use with generator AVRs shall be of accuracy class 0.5.

Voltage transformers for protection purposes shall be of accuracy class 3.

One side of the low voltage winding of single phase voltage transformers and the star point of three phase voltage transformers shall be earthed via an earthing link.

Voltage transformers shall be protected on the HV side by high rupturing capacity, short circuit current limiting fuses in accordance with IEC 60282-1. Fuses shall be readily accessible and suitable arrangements shall be made for safe replacement of fuses whilst the busbar system remains live. On the LV side, industrial type cartridge fuses or miniature circuit breakers shall be provided. All protective devices shall be capable of handling the inrush currents under all service conditions, without abnormal ageing or deterioration. The rating of the protection devices shall be selected in such a way that selective coordination with upstream and downstream protection is guaranteed.

Voltage transformers for use with generator AVRs shall not be protected by fuses but shall be connected within the protection zone of the generator differential protection.

Add new clause:

5.111 CURRENT TRANSFORMERS

Current transformers shall be in accordance with IEC 60185. The rated output shall match the requirements of the equipment connected. The secondary current rating shall be either 5 A or 1 A. For remote metering only 1 A is acceptable.

Secondary terminals of current transformers shall be wired up to a terminal block with short circuiting links, located at an accessible place. At this terminal block one side of each transformer shall be connected to earth.

Current transformers for measuring purposes shall be of accuracy class 3 except those for measuring the supply from third parties, which shall be of class 1. The instrument security factor (FS) shall be 5 or less in order to prevent damage of instruments at maximum fault current.

Current transformers for protection purposes shall be of accuracy class 5P, except in cases where class 10P is specified as adequate by the relay Manufacturer. Current transformers shall have an appropriate VA rating and a saturation factor that will ensure the proper working of the protective devices for all short-circuit currents up to the rated value of the switchgear.

Where required by some types of differential protection, the CTs shall be specified in terms of knee-point voltage, excitation current and secondary winding resistance so as to ensure stability under through fault conditions.

Add new clause:

5.112 MEASURING AND RECORDING INSTRUMENTS

The type and quantity of the measuring/recording instruments is indicated on the relevant standard drawings, where necessary supplemented by information provided on DEP 33.67.51.80-Gen. attached to the requisition.

Instruments shall be of the flush mounting type and shall have an enclosure with a degree of protection of at least IP 52. They shall be equipped with non-glare, non-reflecting windows. Standardized dimensions shall be used in accordance with IEC 60473.

Indicating instruments shall be in accordance with the relevant IEC standards and have an accuracy class 2.5. They should be of the square pattern type 72 x 72 or 96 x 96 mm, and mounted at a suitable height for easy reading from the front. Scales shall be in actual values.

Ammeters for motor duty shall have a compressed overload scale and shall be able to withstand the motor starting currents.

A 4-20 mA output transducer complying with IEC 60688 shall be provided for each analogue signal to a remote supervisory system (e.g. DCS). Detailed requirements will be specified with the requisition.

Recording instruments shall be in accordance with the relevant IEC standards with an accuracy class 2.5, except those for measuring the supply of third parties which shall be of class 1.0.

Watt-hour, VAr-hour and maximum demand meters shall have 5 A elements and cyclometric type register. VAr-hour and Watt-hour integrating meters shall be fitted with a pulse transmitter for input to a remote supervisory system, or a metering summation scheme if indicated on the requisition.

Watt-hour meters in motor circuits, if specified, may be of the single element balanced load type.

Indicating instruments shall be installed in the associated functional units. Recording instruments, if required, may be mounted in any other accessible location or common panel provided that the equipment is properly labelled.

Alarm contacts shall be closed under healthy operating conditions and shall open to alarm.

Add new clause:

5.113 PROTECTIVE DEVICES

5.113.1 Fuses

Fuses used in HV circuits shall be in accordance with IEC 60282-1 and shall be of the high rupturing capacity, short circuit limiting type. The use of more than two fuses in parallel per phase shall be subject to approval by the Principal.

In LV circuits miniature circuit breakers in accordance with IEC 60947-2, or industrial cartridge fuses, in accordance with IEC 60269, shall be used for the protection of control, measuring and auxiliary circuits.

Each individual branch circuit from an auxiliary bus wiring system shall be provided with a selectively graded protective device.

NOTE This is not required for panel anti-condensation heaters (5.101).

5.113.2 Protective relays

5.113.2.1 General

Reference is made to standard drawings S 67.027, S 67.028, S 67.040, S 67.041, S 67.045, S 67.046, S 67.047, S 67.048, S 67.049, S 67.050, S 67.051, S 67.052, S 67.053, S 67.054, S 67.055, S 67.056, S 67.057, S 67.058, S 67.059, S 67.060 and S 67.071.

Protective relays shall be flush mounted and of the withdrawable type, and have an enclosure with a degree of protection of at least IP 5X. They shall be provided with calibration and testing facilities. Current carrying terminals shall be automatically short circuited when the relays are withdrawn.

Relays shall be capable of withstanding the output current of the associated current transformers corresponding to a primary current equal to the specified short circuit withstand current and withstand time of the assembly.

Contact rating and performance shall be in accordance with IEC 60255.

Digital protective relays are acceptable if they are equipped with 'watchdog' facilities.

Protective relays shall derive their power supply from the tripping supply bus-wiring (8.5), or, in the case of motor protection relays in electrically held contactor panels, from the dedicated voltage transformer in the panel. The relays shall not initiate a trip of the circuit in case of a loss of power supply.

Protective relays shall have clear operating indications, e.g. flags for mechanical type relays or light emitting diodes for static type relays. Protective relays should have manual reset facilities; however, if manual reset is not available, a separate lock out relay with manual reset facilities shall be provided. However, the tripping of the switching device shall be done directly by a separate contact of the protective relay.

Non-tripping relays and under-voltage and under-frequency relays for load shedding shall be self-resetting but their operation until reset manually shall be indicated.

Precautions shall be taken to ensure that relays will not operate accidentally owing to

vibration or shocks, e.g. by opening and closing of doors or switching devices.

5.113.2.2 Overcurrent relays

Overcurrent relays should incorporate facilities for selecting different types of inverse definite minimum time (normal, very and extremely) and definite time characteristics, and high set instantaneous elements which can be set on infinity if not required.

5.113.2.3 Earthfault relays

Earthfault relays for consumers, e.g. motors, heaters, etc., shall operate instantaneously. If installed in a fused contactor functional unit, the earthfault protection shall be of the core balance type.

In cases where the earthfault protection must coordinate with downstream earthfault protection, relays with characteristics similar to the above described overcurrent relays shall be selected.

5.113.2.4 Motor overload and single phase protection

Motor overload and single phasing protection relays shall have thermal characteristics.

In contactor motor starter units, relays with 2 or 3 overcurrent elements and single phasing protection shall be utilized.

In circuit breaker motor starter units relays with 2 or 3 overcurrent elements and single phasing protection as well as with instantaneous high set overcurrent and instantaneous earthfault elements shall be used.

5.113.2.5 Undervoltage relays

An undervoltage relay shall be installed in each section of the switchgear containing motor starting units equipped with circuit breakers or latched contactors. The operation shall be instantaneous and the drop out value shall be adjustable between 50 and 65% with a pick up value of not less than 85% of the system voltage.

The undervoltage relays shall energize via a buswiring system a time delayed tripping relay adjustable between 0.2 and 5.0 s in each motor starting unit.

The undervoltage relays shall be of the automatic reset type with manually reset operation indication. The contact rating shall be sufficient for energizing simultaneously the connected time delayed tripping relays.

5.113.2.6 Restarting facilities

If indicated on the requisition, each motor contactor compartment shall be equipped and wired with a U-type relay base of the Sprecher and Schuh type, for future insertion of a restart relay. Restart relays shall be of the RR or TMR type.

The type is dependent on the motor control arrangements; reference is made to Standard Drawing S 67.028. Restart relays shall only be included for those motors as indicated on DEP 33.67.51.80-Gen. attached to the requisition.

Add new clause:

5.114 CABLE TERMINATIONS

Cable compartments shall be of adequate size for splitting, sealing and terminating single or multi-core cables including the utilization of stress cones, if required, as specified in the requisition or attached schedules. Cable end boxes or sleeves shall be of the split type.

Cable glands and the mounting plate for single core cables shall be of non-magnetic material. The glands shall be insulated from the framework and the mounting plate.

When specified on the requisition, glands shall be supplied by the switchgear Manufacturer for all main and control cables as indicated on DEP 33.67.51.80-Gen.

Separate termination compartments for HV and LV connections shall be provided.

Inside the compartments, adequate provisions shall be fitted for earthing the screen and/or armouring of each cable independently.

SECTION SIX RULES FOR TYPE TESTS

Add to this Section:

Type tests shall be carried out in accordance with IEC 298 provided that additional requirements specified (e.g. busbar insulation) are taken into consideration.

Certificates shall be available at the quotation stage. Certificates issued/supported by independent testing laboratories are preferred.

Components installed within the assembly shall be type tested in accordance with the applicable IEC standards. Certificates obtained from the component Manufacturers shall be made available at the request of the Principal.

SECTION SEVEN RULES FOR ROUTINE TESTS

Add to this Section:

The Manufacturer shall perform routine tests in accordance with IEC 298 on the total assembly. However, if the equipment will be shipped in units at different times, the routine tests may be performed on the separate units. The results shall be recorded in a test report.

If indicated on the requisition or order, the Principal or his Nominee shall witness the final routine testing.

Transportable units may be wired together instead of completing busbar joints.

At least the following checks and tests shall be carried out.

Switchgear shall be visually inspected for conformity with the latest issue of the approved drawings and with the order. The following shall be verified:

- the degree of protection of the enclosure;
- the degree of protection within the compartments;
- the effectiveness and reliability of safety shutters, partitions and shrouds;
- the effectiveness and reliability of operating mechanisms, (pad)locks and interlock systems;
- the insulation of the busbar system;
- the creepage distances and clearances;
- the proper mounting of components;
- the internal wiring and cabling system;
- the correct wiring of main and auxiliary circuits;
- the suitability of clamping, earthing and terminating arrangements;
- the correct labelling of functional units;
- the completeness of the data on the nameplate;
- the availability of the earthing system throughout the switchgear;
- the interchangeability of electrically identical components;
- the non-interchangeability of mechanically identical but electrically different components.

Insulation resistance testing shall be carried out by applying a Megger between each phase and earth, with the two remaining phases connected to earth. This test shall be carried out with all manually operated and latched type switching devices closed in the service position and all main fuses installed.

Testing of the mechanical and electrical operation of a number of functional units on a random basis, including their control and protective devices. Unless otherwise agreed, tests shall be done on 10% of the number of similar functional units with a minimum of two units. If these tests fail, further operational tests shall be performed on all panels.

NOTE Similar functional units are motor feeders, or transformer feeders, or plain feeders, etc.

SECTION EIGHT GENERAL INFORMATION

8. GUIDE TO THE SELECTION OF SWITCHING DEVICES FOR SERVICE

Add new clause:

8.1 GENERAL

Depending on the requirements, the assembly may include the following type of functional units:

- Incoming: Generator feeder
  Incoming feeder

- Coupling: Sectionalizer
  Buscoupler

- Outgoing: Distribution feeder
  Transformer feeder
  Motor starter
  Capacitor bank

The type of device to be selected depends on the circuit protection and control requirements.

For circuits which are not to be tripped by protection devices and which do not have synchronising facilities, e.g. incoming and sectionalizer units, a general purpose switch (fault make and load break) may be considered.

For end circuits feeding, for example, motors and capacitor banks, and for circuits feeding LV power transformers, fused contactor (vacuum or SF_6) units shall be used depending on the availability of the appropriate type of fuses and contactors.

For all other functional units circuit breakers shall be used.

As switching medium, either of the following may be selected:

- vacuum;
- gas (SF_6).

Subject to the approval of the Principal, oil or air type circuit breakers may be selected.

Switching devices using SF_6 as switching medium, which are not provided with independent switching containments per phase and are guaranteed "sealed-for-life", shall be provided with pressure indication with contacts wired up to an alarm circuit.

All HV latched type switching devices shall be provided with a mechanical, manually operated tripping device.

Add new clause:

8.2 SWITCH UNITS

Switches shall comply with IEC 60265 and shall be selected as general purpose switches for use under standard conditions of service (Category A).

One of the following operating mechanisms shall be selected:

- independent manual operation;
- stored energy operation;
- dependent power operation.

Add new clause:

8.3 FUSE CONTACTOR UNITS

Contactors shall comply with IEC 60470 and shall be suitable for intermittent duty class 0.1 as well as for uninterrupted duties. The utilization category shall be AC-3.

The minimum short circuit breaking capacity of the contactor shall be at least 6 kA at rated voltage.

Anti-pumping devices shall be included to prevent 'pumping actions' of mechanisms.

Contactors for motor starter service shall be provided with a closing-holding coil energized from a dedicated voltage transformer per functional unit, installed on the withdrawable part. The secondary voltage shall be 230 V.

Contactors for LV power transformer and capacitor bank feeders shall have latched mechanisms deriving the closing voltage from a dedicated transformer as above or from the closing supply system for circuit breakers as specified under clause 8.5. The tripping supply shall be obtained from the DC tripping supply system also specified under clause 8.5. (ref. Standard Drawing S 67.049).

For typical motor feeders, reference is made to Standard Drawings S 67.028 and S 67.045. For typical transformer feeders reference is made to Standard Drawing S 67.049.

Motor contactor panels shall be provided with restarting facilities as specified in clause 5.113.2.6, if specified on the requisition.

Fuse links shall be in accordance IEC 60282-1 and shall have high rupturing capacity. They shall be short circuit current limiting. Fuses shall be provided with a striker pin arrangement tripping the contactor.

Fuses for motor starters shall have a time-current characteristic suitable for direct on-line motor starting.

Correct discrimination shall be established between fuse characteristics and contactor breaking capacities. This shall ensure that overload and fault currents are safely interrupted by the appropriate devices thereby avoiding any risk of welding or other damage of the contactor.

Fused contactor units shall be provided with main circuit isolating facilities which can be operated from outside the switchgear without opening a panel. The isolated position shall have padlock facilities. The isolating facilities shall be equipped with interlocking features to prevent the isolator being opened when the contactor is in the closed position.

NOTE A withdrawable type switching device may be considered to satisfy this requirement, provided the isolation, re-energizing and padlocking can be performed with the panel closed.

The design shall exclude the possibility of backfeed via the voltage transformer when a unit is withdrawn and its auxiliary connections are made via a test link.

Add new clause:

8.4 CIRCUIT BREAKER UNITS

Circuit breakers shall be in accordance with IEC 60056.

One of the following operating mechanisms may be selected:

- stored energy operation;
- dependent power operation.

Anti-pumping devices shall be included to prevent 'pumping actions' of the mechanism.

Circuit breakers in motor starter circuits shall be suitable for utilization category AC-3. For typical control circuits for HV motors reference is made to Standard Drawing S 67.071.

Add new clause:

8.5 SUPPLY VOLTAGES FOR CLOSING, TRIPPING AND PROTECTION

The supply arrangement for closing, tripping and protection shall be one of the following:

- combined DC supply unit(s) with battery back-up for closing, tripping and protection;
- DC supply unit(s) with battery back-up for tripping and protection and AC supply for closing.

Multi-section assemblies shall have two DC supply units (Annex HH gives minimum requirements). Clearly labelled switching arrangements shall be provided in accordance with Standard Drawing S 67.040 or S 67.041. The switching arrangements for both systems shall enable each unit to supply:

1. one section (or two sections in a three-section assembly) of the switchboard closing, tripping and protection supply load;
2. the total switchboard closing, tripping and protection load when the other unit is isolated from the system.

Voltages for closing of circuit breakers shall be 230 V AC or 110 V DC in combined closing, tripping and protection supply units.

For tripping and protection supply, the voltage shall be 110 V DC. If another voltage is required (e.g. 30 or 48 V DC), this will be stated on the requisition. Each supply unit shall be capable of closing or charging at least two switching devices simultaneously and all others in succession per assembly. However, if the supply unit also serves circuit breakers for motor feeders, each supply unit shall be rated for simultaneous closing of at least 30% of all motor feeders of the assembly with a minimum of two units. In addition to this, the battery of each supply unit shall be capable of supplying the whole assembly control circuit load including the supply to electronic relays, if applicable, for a period of minimum 8 hours and then be able to trip all connected switching devices in succession. Trip circuits shall normally be de-energized with energizing to trip.

The output voltage ripple of the DC supply shall not cause interference with the other equipment of the assembly.

The closing or tripping of switching devices shall not result in a voltage of less than the permissible voltage specified for the installed protective relays.

If specified on the requisition, a healthy trip indicator shall be provided on all units with electrical tripping. Any loss of trip supply shall operate an alarm relay with contacts wired up for a remote alarm possibility.

For installations in e.g. main intake, power plant stations or large plant substations where a number of switchgear assemblies are installed, preference may be given to the use of duplicated common DC supply for control, signal, protection and alarm functions. The (duplicated) DC supply should be of ample capacity and provided with a selective DC distribution switchboard, incorporating earth leakage monitors per outgoing circuit. If such a system is required, a detailed specification of the rectifiers, batteries and distribution switchboard will be attached to the requisition.

If switching devices are remotely controlled, a positive closing and tripping action shall be possible under all conditions up to 500 m using 2.5 mm^2 control cabling. For longer distances, or if a different type of cable is used, this will be specified in the requisition or on DEP 33.67.51.80-Gen.

9. INFORMATION TO BE GIVEN WITH ENQUIRIES, TENDERS AND ORDERS

Add new clause:

9.103 ADDITIONAL REQUIREMENTS

The Manufacturer shall supply at least the following drawings/documents in the quantities and at the times stated in DEP form 40.10.01.93-Gen., attached to the requisition.

a. single-line diagram*;
b. schematic diagrams of all different types of circuits;
c. final assembly arrangement drawing showing main circuits, main dimensions, panel layout, floor plan and shipping sections*;
d. minimum clearances around the assemblies for ventilation and safety during operation and maintenance*;

e. total mass of the assembly and of the individual shipping sections*;
f. transport, installation, commissioning, operation and maintenance instructions, limited and specific to the assembly and its components;
g. list of recommended spare parts (see DEP 70.10.90.11-Gen.);
h. list of applicable type test certificates;
i. test report of the final routine testing.

NOTE Drawings marked with * may be combined, provided all information indicated above is included.

All documents shall show the relevant order number, item and Manufacturer's references.

With the tender, the Manufacturer shall supply as a minimum preliminary general arrangement and floorplan drawings, also indicating the minimum required clearances around the assemblies.

The language used shall be as specified on the requisition.

10. RULES FOR TRANSPORT, STORAGE, ERECTION AND MAINTENANCE

Add to this Section:

Assemblies supplied in transport units shall have these units clearly marked to facilitate assembly at site.

Instructions for transport, storage, erection and maintenance of the equipment shall be supplied by the Manufacturer as an integral part of the order.

Special tools and equipment required for erection, commissioning, and maintenance shall form part of the order and shall be shipped together with the assembly.

Add new Annex:

ANNEX HH DC SUPPLY UNITS FOR HV ASSEMBLIES

HH.1. GENERAL REQUIREMENTS

HH.1.1 BASIS OF DESIGN

The DC supply units shall be designed to minimize any risk of short circuits and to ensure personnel and operational safety under all conditions of operation, inspection and maintenance.

All components shall be of a quality and reliability that satisfies the requirements of a secure DC source of power for energizing protection relays, tripping and closing of circuits of high voltage switchgear assemblies.

The design and selection of components shall be based on achieving a minimum lifetime of 20 years.

Component materials shall be non-flame propagating, wherever practicable.

Electrolytes, e.g. for capacitors, shall be non-toxic and totally free of polychlorinated biphenyls.

HH.1.2 EQUIPMENT ARRANGEMENT

The DC supply unit shall comprise the following items:

- one constant-voltage, current-limiting rectifier;
- one battery;
- auxiliary equipment.

Each DC supply unit shall have facilities for operation in the battery float-charge mode and in the battery rapid-charge mode.

In the event of failure of the AC mains supply to the rectifier, the battery of the DC supply unit shall, without interruption, take over and supply the power requirements as specified in (HH.2.3) below.

The DC circuit of the supply unit shall be operated free from earth.

If two units are provided for an HV assembly, they shall be capable of operating under the change-over switching conditions specified in (8.5).

NOTE Blocking diodes may be necessary.

HH.1.3 SERVICE CONDITIONS

Unless otherwise specified, the unit(s) shall be installed adjacent to the HV assembly or in a separate room with a similar environment.

HH.1.4 ELECTRICITY SUPPLY

The AC supply voltage to the DC supply unit shall be specified on the requisition. The input voltage can be subject to transients comprising voltage depressions up to 20% of nominal voltage during motor starting, and to voltage interruptions during system short circuits. Transient high-frequency voltages of 2 kV peak may also be superimposed on the input voltage as a consequence of system switching operations etc.

HH.2. PERFORMANCE REQUIREMENTS

HH.2.1 D.C. SUPPLY UNIT RATING

The rated output current of the rectifier of the D.C. supply unit shall be not less than the

following:

- the continuous current requirements of loads connected to the DC buswires throughout the entire switchboard assembly (e.g. protection relays, auxiliary relays etc.);
- plus the current requirement of the battery in the float charge-mode;
- plus the current required to close/charge a single switching device and trip another single switching device at the same time.

The battery of each supply unit shall be rated to achieve the discharge performance requirements specified in (HH.2.3).

The supply unit shall be suitable for continuous duty while operating under the specified service conditions and fulfilling the performance requirements specified below.

HH.2.2 BATTERY FLOAT-CHARGE OPERATION

The rectifier steady-state DC output voltage variations shall be controlled to plus 1% and minus 1% of the set value for all currents between zero and the rated output current of the rectifier.

The current ripple limits specified by the battery Manufacturer shall not be exceeded.

HH.2.3 BATTERY DISCHARGE OPERATION

The battery shall be rated to supply the continuous current requirements of loads connected to the DC buswires throughout the entire switchboard assembly (e.g. protective relays, auxiliary relays etc.) for a period of 8 hours and then be able to trip consecutively all switching devices installed on the entire switchboard assembly.

The battery discharge requirements shall be fulfilled:

- under the prevailing service conditions, including the minimum ambient temperature specified;
- after a prolonged period (not less than one year) of continuous float-charge operation of the battery.

HH.2.4 BATTERY RAPID-CHARGE OPERATION

When operating in the rapid-charge mode, the rectifier shall restore the battery, within a period of 12 hours, from the capacity reached at the end of the discharge performance specified in (HH.2.3) to a capacity that will again enable the battery to fulfil the specified discharge performance requirements.

Operation of the battery rapid-charge selector switch shall initiate an automatically controlled rapid-charge cycle according to a constant current, constant voltage characteristic.

The duration of the rapid-charge operation shall be controlled by an adjustable timing relay which, after the elapsed time, will re-instate the rectifier output voltage to that corresponding to continuous float-charge operation.

Facilities shall be provided for on-line adjustment of the set value of final voltage applied to the battery, but only by access to the relevant control circuit card.

HH.2.5 D.C. SUPPLY UNIT OUTPUT VOLTAGE

During float charging of the battery, the DC circuit voltage shall not exceed 110% of the nominal DC circuit voltage.

During discharge of the battery for the specified time, the DC circuit voltage shall not fall below 80% of the nominal DC circuit voltage, or below the minimum specified for the connected equipment (e.g. protection relays), whichever is the more stringent.

Voltage regulating devices, e.g. switched supplementary battery cells or voltage-dropping diodes, shall not be used to maintain the DC output voltage within the above tolerances.

HH.3. CONSTRUCTIONAL REQUIREMENTS

HH.3.1 UNIT ENCLOSURE AND ACCESSIBILITY

Each rectifier shall be installed in a freestanding or wall-mounted self-supporting sheet steel cabinet forming an enclosure. The cabinet shall be suitable for operation and maintenance with its rear panel against a wall and with similar units located immediately on both sides.

The enclosure shall provide a degree of protection of not less than IP 3X in accordance with IEC 60529. The floor shall not be considered as forming part of the enclosure. Internal cooling shall be by natural ventilation. The working temperature of the components shall not have a detrimental effect on any other components.

When opened, the enclosure shall offer a degree of protection of at least IP 2X towards any live part.

The battery may be installed either in a separate compartment of the rectifier cabinet or in a separate cabinet adjoining that of the rectifier.

Battery enclosures shall be naturally ventilated to disperse gaseous products. The battery shall be positioned so that possible leakage of electrolyte or emission of gaseous products shall not cause damage to other equipment, components in the rectifier compartment or adjacent cells.

HH.3.2 BATTERY CELLS AND CONTAINERS

Battery cells shall be of the nickel cadmium, restricted breathing type. Cells shall be fitted with flame-arresting vent plugs. Cell containers of plastic material are preferred, subject to the material being non-flame propagating and mechanically shock resistant. Plastic containers shall permit the electrolyte level to be viewed through the container material.

Intercell connections and terminals shall be insulated or otherwise provided with a protective covering to prevent inadvertent short circuiting. The battery shall be supplied complete with ready-mixed liquid electrolyte.

For installations in e.g. main intake, power plant, or large substations, the DC supply may be derived from a central battery installation (8.5). A lead-acid battery of the Plante type or of the sealed, gas recombination type may then be specified. Terminal pillar seals of lead-acid batteries shall be of a type that prevents the initiation of pillar corrosion.

HH.3.3 WIRING, TERMINATIONS, EARTHING, MOUNTING OF EQUIPMENT, SHROUDING AND MARKING

The above shall conform to the requirements for LV and secondary equipment on the assembly.

HH.4. AUXILIARY EQUIPMENT

HH.4.1 INDICATORS AND ALARMS

As a minimum, the following indicator equipment with manual reset shall be provided at each DC supply unit:

- low-voltage DC at output terminals;
- AC supply failure;
- earth fault.

In addition, a voltage-free set of change-over contacts shall be provided for remote alarm. The initiation of the above alarms/indicators shall be time-delayed so that they are substantially unaffected by transients.

HH.4.2 MEASUREMENTS

As a minimum, the following parameters shall be measured and displayed:

- DC unit output voltage;
- DC unit output current.

HH.5. PROTECTION

Selectively operating protective devices shall be incorporated as required to safeguard the unit and its components from the consequences of internal or external short circuits, overvoltages, etc.

Readily available standard industrial fuse links are preferred.

HH.6. INSPECTION AND TESTS

Prior to despatch the Manufacturer shall verify that the units comply with this DEP.

Functional checks shall be carried out on rectifiers and the operation of all measuring instruments, alarms, indicators, protective and control circuitry shall be verified.

The results of these tests and any type test that supports compliance with the requirements of this specification shall be available prior to switchboard testing.

The DC supply unit(s) shall be available for visual examination when the switchboard is being witness tested.

PART III REFERENCES

In this DEP, reference is made to the following publications:

NOTE Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Schedule for HV switchgear and controlgear assemblies	DEP 33.67.51.80-Gen.
Requisition for HV switchgear and controlgear assemblies	DEP 33.67.51.93-Gen.
Requisition for engineering documents	DEP 40.10.01.93-Gen.
Spare parts for initial and normal operation	DEP 70.10.90.11-Gen.

STANDARD DRAWINGS

High voltage switchgear and controlgear assemblies identification of sections and panels	S 67.027
Schematic diagrams of control circuits for HV motors (contactor starters)	S 67.028
Arrangement of tripping and closing supply (2-section board)	S 67.040
Arrangement of tripping and closing supply (3-section board)	S 67.041
Motor controlled by contactor	S 67.045
Motor controlled by circuit breaker	S 67.046
Large synchronous motor	S 67.047
Motor with unit transformer	S 67.048
HV/LV transformer < 1600 kVA, controlled by contactor	S 67.049
HV/LV transformer < 1600 kVA, controlled by circuit breaker	S 67.050
HV/HV transformer including feeder cable $\leq$ 250m	S 67.051
HV/HV transformer including feeder cable > 250m	S 67.052
Parallel plain feeder	S 67.053
Single plain feeder	S 67.054
Generator directly connected (voltage $\leq$ 11 kV)	S 67.055
Generator with unit transfomer (voltage > 11 kV)	S 67.056
VSDS with synchronous motor	S 67.057
Submerged motors (contactor starter)	S 67.058
Overhead line circuits (33 - 132 kV)	S 67.059
Grid supply incomer with on-site generation	S 67.060
Schematic diagram of control circuits for HV motors (circuit breaker starters)	S 67.071

INTERNATIONAL STANDARDS

A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and incl. 52 Kv	IEC 298 (1990, plus AMD 1-1994-11)
High-voltage a.c. circuit breakers	IEC 60056
Electrical apparatus for explosive gas atmospheres Part 10: Classification of hazardous areas	IEC 60079-10
Current transformers	IEC 60185
Voltage transformers	IEC 60186
Electrical relays	IEC 60255
High-voltage switches	IEC 60265
Low-voltage fuses	IEC 60269
High-voltage fuses (part 1)	IEC 60282-1
Identification of equipment terminals and of terminations of certain designated conductors including general rules of an alphanumeric notation	IEC 60445
High-voltage a.c. contactors	IEC 60470
Dimensions for panel-mounted indicating and recording electrical measuring instruments	IEC 60473
Degrees of protection provided by enclosures (IP Code)	IEC 60529
Electrical measuring transducers for converting a.c. electrical quantities to analogue or ditigal signals	IEC 60688
Common clauses for high-voltage switchgear and controlgear standards and controlgear standards	IEC 60694
Low-voltage switchgear and controlgear Part 2: Circuit breakers	IEC 60947-2

Issued by:
Central Office of the IEC (Sales Dept.)
3, Rue de Varembé
1211 Geneva 20
Switzerland.
Copies can also be obtained from national standards organizations.

APPENDIX 1 TECHNICAL SPECIFICATION OF GAS-INSULATED SWITCHGEAR BETWEEN 24 kV and 36 kV

This Appendix gives the **additional** requirements to IEC 298 for gas-insulated switchgear (GIS) between 24 kV and 36 kV.

In this Appendix the sections and clauses marked with an asterisk (*) refer to the sections in the main body of this DEP which shall also apply to GIS.

Sections and clauses within the main body of this DEP but **not** mentioned in this Appendix **do not apply.**

*SECTION 2 SERVICE CONDITIONS

Applies without further changes.

*SECTION 3 TERMS AND DEFINITIONS

Applies without further changes.

*SECTION 4 RATED CHARACTERISTICS

Applies without further changes.

SECTION FIVE DESIGN AND CONSTRUCTION

Switchgear and controlgear shall be designed to minimize any risk of short circuits and to ensure personnel and operational safety during all operating conditions, inspections and maintenance.

GIS switchgear shall be designed for continuous operation at full load for at least 90 000 hours without maintenance, unless the total number of allowed switching operations is exceed.

Switchgear and controlgear shall be of the metal-clad, SF_6 gas-insulated non-withdrawable type, having either a single or double busbar system, and consist of a number of separate panels assembled into one or more sections. Sections shall be electrically interconnected by a sectionalizing switching device.

Double busbar systems shall have facilities for being electrically coupled for each section by a buscoupler. Each busbar system shall be fully segregated, making it possible to safely extend one system when the other system is energized.

Facilities for extension of the switchgear shall be provided at both ends.

The lay-out of the operational front and the location of the components of the assembly shall be arranged in a logical and systematic sequence and standardized throughout. No operational equipment or metering apparatus shall be located at levels below 200 mm and above 2 000 mm. If the latter is not possible due to space constraints, details of the equipment to be installed above 2 000 mm shall be given in the quotation.

Alphanumeric notation, generally in accordance with IEC 445, shall be used for identification and marking of phases, conductors and terminals.

5.2 REQUIREMENTS FOR GASES IN SWITCHGEAR AND CONTROLGEAR

Add to this clause:

SF_6 gas shall be used as insulation medium. Gas used as insulation medium shall be fully segregated from any gas used for switching medium. Gases other than air may be used as switching medium after approval of the Principal.

5.3 EARTHING

Add to this clause:

For direct connection to the station earthing grid, earthing bolts of at least M10 shall be provided at both ends of the main earth bar.

An integrated three position isolator, with busbar connected/isolated/earthed positions, shall be provided. A circuit or busbar earth shall only be applied via the HV switching device.

The three position isolator switch shall be interlocked to prevent operation when the HV switching device is in the closed position.

A capacitive three phase voltage indicator system shall be installed, indicating voltage on all outgoing feeders on the front and preferably on the rear of the panels and all sections of the busbar system on the front of the sectionaliser panel(s).

The busbar earthing system shall be integrated with the sectionaliser HV switching device.

Circuit and busbar earthing devices shall be arranged for local, manual operation only.

Earthing devices shall be equipped with a mechanically operated position indicator which shall be clearly visible without removal or opening of panel doors or covers.

Padlocking facilities shall be provided for locking the three position isolator in the isolated or earthed position.

Padlocking facilities shall be provided for locking the HV switching device electrically and mechanically in the closed position when the three position isolator is in the earthed position.

Clear instructions, preferably pictorial, shall be installed showing the procedure for earthing.

*CLAUSE 5.4.1 Auxiliary contacts

Applies without further changes.

*CLAUSE 5.4.2 Secondary wiring and terminal

Applies without further changes.

*CLAUSE 5.9 Name plates

Applies without further changes.

5.101 DEGREE OF PROTECTION AND INTERNAL FAULT

5.101.1 Protection of persons against approach to live parts and contact with moving parts

Add to this clause

For the partitions between compartments a degree of protection of at least IP 3X and between panels of IP 4X shall be achieved, which shall be maintained under all operational conditions. Busbar compartments of different sections of the switchboard shall have a partition with a degree of protection of at least IP 4X.

NOTE Busbar compartments of a section do not require to have partitions between the individual panels.

LV compartments shall be easily accessible and, when opened, shall offer a degree of protection of at least IP 2X towards any live part inside the compartment and on the door.

5.101.2 Protection of equipment against external effects

Add to this clause:

The degree of protection of the enclosure shall be at least IP 4X as specified in IEC 529. The floor of the switch room shall not be considered to be part of the enclosure.

The degree of protection of the gas filled enclosure shall be at least IP 64 as specified in IEC 529.

The degree of protection of the low voltage compartments shall be at least IP 4X and the top of the LV compartment shall be sealed to such an extent that the ingress of dripping water is prevented.

5.101.4 Internal fault

Add to this clause

Switchgear enclosures shall comply with Annex AA with regard to their mechanical strength in the event of an internal arc. The test performance shall be in conformity with accessibility type A.

All switchgear assemblies shall be type-tested at the rated short circuit current with an arc duration of 0.5 s minimum; however, testing for a duration of 1 s is preferred.

Compliance with Annex AA through the correct operation of a purpose built pressure relief system is acceptable.

The test shall be executed for all separate compartments within the functional unit containing HV equipment, i.e. busbar compartment, circuit breaker/contactor compartment and cable compartment.

Type test reports regarding internal arc withstand performance shall be available in the quotation stage.

***5.102.1 General**

Applies without further changes.

5.102.2 Design of gas-filled compartments

Add to this sub-clause

“Controlled” pressure system, as defined in Annex GG, shall not be used to maintain the pressure in a gas filled compartment.

Facilities shall be provided to safely top up all gas filled compartments, excluding switching medium compartments, without de-energisation of the gas compartment. All top up points shall have non return valves to prevent inadvertent depressurisation during the topping up operation.

5.102.3 Tightness of gas filled compartments

Add to this sub-clause

The relative leakage rate F_{rel} shall be less then 1 % per year as specified in IEC 298 Annex GG.

The time between refilling (T) shall be at least 10 years as specified in IEC 298 Annex GG.

Type test reports, complying with Annex GG, regarding tightness of gas filled compartments shall be available in the quotation stage.

Each gas filled compartment where the normal operating pressure exceeds 1 bar (gauge) shall be fitted with a pressure indication gauge with a low pressure alarm contact. The low pressure alarm contact should be set halfway between normal operating pressure and the minimum functional pressure.

5.104 PRESSURE RELIEF OF GAS FILLED COMPARTMENTS

Add to this clause

Pressure relief that relies on allowing the arc to burn through the enclosure at designated points shall not be used.

5.106 INTERLOCKS

Add to this clause

For a double busbar system, “busbar transfer without current interruption” is not required unless specifically stated in the requisition.

Add new clause:

5.108 SYSTEMS

Busbar systems shall be located in separate, SF_6 gas filled compartments.

Provisions shall be made at the bolted connections to enable accessibility for maintenance and extensions when appropriate.

Busbars shall be made of copper. Aluminum bars may be considered, but shall be subject to approval by the Principal.

All bolted connections shall be made with high tensile strength bolts effectively secured against loosening.

Add new clause:

5.110 VOLTAGE TRANSFORMERS

Voltage transformers shall be in accordance with IEC 186. The rated output shall match the maximum load of the equipment connected plus 25%, and should be selected from the range of standard values. The preferred secondary voltage is 110 V.

Voltage transformers for measuring purposes shall be of accuracy class 3, except those for measuring the supply of third parties, which shall be of class 1. Voltage transformers for use with generator AVRs shall be of accuracy class 0.5.

Voltage transformers for protection purposes shall be of accuracy class 3.

One side of the low voltage winding of single phase voltage transformers and the star point of three phase voltage transformers shall be earthed via an earthing link.

Voltage transformers shall be encapsulated type single phase or three phase and shall be connected via an isolator device.

Busbar voltage transformers shall be directly connected to the gas-insulated busbar systems without any HV cable connections. Any normally live connection, on the primary side of a voltage transformer, that is not within a gas filled compartment shall be fully insulated to withstand at least the line voltage of the system.

It shall be possible to isolate the voltage transformer without depressuring any gas filled compartment.

On the LV side, industrial type cartridge fuses or miniature circuit breakers shall be provided. All protective devices shall be capable of handling the inrush currents under all service conditions, without abnormal ageing or deterioration. The rating of the protection devices shall be selected in such a way that selective coordination with upstream and downstream protection is guaranteed.

Voltage transformers for use with generator AVRs shall not be protected by fuses but shall be connected within the protection zone of the generator differential protection.

***CLAUSE 5.111 CURRENT TRANSFORMERS**

Applies without further changes.

***CLAUSE 5.112 MEASURING AND RECORDING INSTRUMENTS**

Applies without further changes.

***CLAUSE 5.113 PROTECTIVE DEVICES**

Applies without further changes.

5.114 CABLE TERMINATIONS

Add new clause:

Cable terminations form an integrated part of the switchgear design and shall be delivered by the switchgear Manufacturer as part of the order package.

Facilities shall be provided for attaching external connections for testing the cable. These facilities should not involve unbolting of the main cable connections to the busbar or de-pressuring any gas filled compartments.

***SECTION SIX RULES FOR TYPE TESTS**

Applies without further changes.

SECTION SEVEN RULES FOR ROUTINE TESTS

Add to this Section:

The Manufacturer shall perform routine tests in accordance with IEC 298 on the total assembly. However, if the equipment will be shipped in units at different times, the routine tests may be performed on the separate units. The results shall be recorded in a test report.

GIS compartments shall be 100% factory tested for gas tightness as specified in IEC 298 Annex GG.

***SECTION 8 GUIDE TO THE SECTION OF SWITCHING DEVICES FOR SERVICE**

***CLAUSE 8.1 General**

Applies without further changes.

***CLAUSE 8.2 Switch units**

Applies without further changes.

***CLAUSE 8.4 Circuit Breaker Units**

Applies without further changes.

***CLAUSE 8.5 Supply voltage for closing, tripping, and protection.**

Applies without further changes.

***SECTION 9 INFORMATION TO BE GIVEN WITH ENQUIRIES, TENDERS AND ORDERS**

Applies without further changes.

***CLAUSE 9.103 Additional requirements**

Applies without further changes.

SECTION TEN RULES FOR TRANSPORT, STORAGE, ERECTION AND MAINTENANCE

Add to this section

Instructions for transport, storage, erection, and maintenance of the equipment shall be

supplied by the Manufacturer as an integral part of the order.

Special tools and equipment required for erection, commissioning and maintenance shall form part of the order and shall be shipped together with the assembly.

A schedule of recommended site tests to establish correct and reliable operation shall be submitted with the quotation.

10.2 ERECTION (MOUNTING)

Add to this clause

Erection and final inspections shall be carried out by the switchgear Manufacturer.

A site test certificate shall be issued by the Manufacturer to confirm satisfactory completion of the recommended site tests.

***ANNEX HH DC supply units for HV assemblies**

Applies without further changes.